try to explain the earth without reference to its past history.

Think of a young morphologist, with all the advantages of the Naples Station at hand—yes, within the walls of that grand station—loudly sneering at Darwinism, and spending his wit in derisive caricatures of general truths beyond the horizon of his special work and thought. And shall we forget the physiologist whose philosopher's stone is the search for his ancestry among the Arachnids? Or the anatomist who reverses his telescope to discover that his science begins and ends in terminology? And could we, much as we might yearn for such a benediction, forget the omnipresent and omniscient systematist whose creed is summed up in priority?

The catholicon for crankiness has not yet been found, but in science there is but one cure where cure is possible; it is exposure to the full and direct rays of the system as a whole. The application to the subject in hand is patent. The one great charm of a biological station must be the fullness with which it represents the biological system. Its power and efficacy diminish in geometrical ratio with every source of light excluded.

My plea, then, is for a biological station, and I believe that experimental biology would be the most important element in such a station. It is now possible to procure a favorable site, with land and fresh-water privileges, in close proximity with the Marine Biological Laboratory; and with a moderate foundation to start with, the work could begin at any moment.

The project is certainly one of preëminent importance, and for a successful undertaking of that magnitude we need the coöperation of American naturalists. I bring the suggestion before you in the hope that it will enlist your interest and support.

C. O. WHITMAN.

RECENT PROGRESS IN AGRICULTURAL CHEMISTRY.

II.

THE methods of the chemical changes produced in the growth of plants have recently received an admirable study at the hands of Green. (Journal of the Royal Agricultural Society of England, Vol. 6, third series, part 4, pp. 635 *et seq.*) The chief object of Green's study is the reserve food materials of plants, but in conducting these investigations he studies carefully the chemical action on which the plant metabolism is based. The apparatus of the plant, which is active in vegetable metabolism, was studied microscopically and fully illustrated by drawings.

The source of chemical activity in plants is confined to certain small bodies which are imbedded in the layer of protoplasm or living substance which lines the cells of the plants. These small bodies are called chloroplastids or chlorophyll corpuscles, and it is to them that we must look for the actual constructive activity. These are comprised essentially of small masses of protoplasm which have a loose or spongy arrangement of particles forming a complicated mesh work. In the meshes of this spongy mass the green color known as chlorophyll is found. It exists principally in solution. The work which is done by the chloroplastid is very complex, but it is possible to distinguish to a considerable extent between the part played by the green coloring matter itself and that which is discharged by its protoplasmic framework. On account of the character of this material the air has ready access to the interior tissues of the leaf. It enters at the stomata and fills the intercellular spaces. This air contains the small quantity of carbon dioxid which is the fundamental material of plant metabolism. The water which is taken in by the rootlets of the plant contains various mineral and nitrogenous matters in solu-

tion and is conducted directly to the leaf by means of the circulation of the plant itself. This water, the mineral and nitrogenous matters which it contains in solution, and the carbon dioxid which enters from the air, are the raw materials which by plant metabolism are changed into the tissues of the living vegetable.

The source of energy, by means of which this wonderful chemical synthesis is produced, is the heat and light coming from the sun. Green is of the opinion that formaldehyd is one of the first products of the condensation of the carbon dioxid, but as formaldehyd is essentially a poison and a preservative it is not probable that its existence is more than momentary. It may be that formaldehyd is one of the transitory products of vegetable metabolism, but it cannot be regarded as being produced in any considerable quantities or existing for any length of time.

The final and possibly the direct product of the condensation is some form of sugar. The production of these reserve stores of food, viz., carbohydrates, proteids and fats in quantities largely in excess of those necessary for the growth of the plant itself are fully discussed, and the very latest views concerning the methods of storage and subsequent use of these materials clearly pointed out.

Investigations of marked interest have lately been conducted on the properties and functions of humus. Hilgard has shown that the nitrogen content of humus found in the soil of the California Agricultural Experiment Station is as much as 18 per cent. in the virgin state. The content of nitrogen in the humus by after years' culture was reduced from 18 to 3 per cent. In the meanwhile, however, the total percentage of humus in the soil had slightly increased.

The obvious conclusion to be drawn from these researches is that the fertility of a soil, in respect of its humus, does not depend so much on the actual percentage of humus itself as upon the nitrogen content therein. When a plant, therefore, gives evidence of nitrogen hunger it is not always due to a deficiency of humus, but probably rather to the diminution of the nitrogen content of the humus.

A more striking example came to Hilgard's attention in a soil from Hawaii, which, after three years of cultivation, gave evidence of marked deficiency in the nitrogen ration of the plant. The virgin soil showed a content of 10 per cent. of humus, which is far above the average of even fertile soils. On analysis, however, it was found that the nitrogen content of the humus had been reduced to 1.7 per cent. It is concluded from the observations of the deportment of crops on soils of this kind that wherever the nitrogen in the humus of the soil falls below 2.5 per cent. of the total weight of the humus the crop will show evidences of nitrogen hunger.

Snyder has shown that in sterilized sand oats will not grow when fed with humus in which no nitrifying ferments are present. If, however, the nitrifying ferments be added in the form of leachings from an arable soil the oats will grow and develop in the usual manner.

Snyder has also shown, as a result of his investigations, that humus acts not only in supplying the elements of fertility, but also in combining with mineral matters, especially potash, producing in the soil potassium humates and rendering the potash thus more easily assimilable. In other words, the humus acts in a favorable manner by converting the inert plant food of the soil into a form in which it can be absorbed. The experiments in sterilized pots show that the humates of potassium, magnesium and iron and the double humates of phosphorus and sulfur can be utilized directly as plant food, provided nitrifying

organisms be present. (Bulletin Minn. Agr. Exp. Sta. No. 41.)

The remarkable property of vegetable soils, consisting largely of humus, in increasing the nitrogen of a cereal crop, has been noticed in the experiments of the Chemical Division of the Department of Agriculture at Washington. In three successive years roots growing in a vegetable soil from Florida have shown an increased percentage of nitrogen as compared with roots grown in the same conditions in typical arable soils. The increase in nitrogen content has, in some instances, been as high as 30 per cent. in a whole crop.

An examination of the character of the nitrogen-content of the soil shows that this increase is largely in the form of amid nitrogen.

I have frequently noticed in Florida the mechanical absorption of humus by a plant in the case of sugar cane grown upon the peaty soils. The juices of these canes often have a distinct brown color which is characteristic of water which has passed through a soil of this nature. The sugar which is made from these canes does not have the bright crystalline appearance of ordinary sugars made from cane, but has a brownish tint difficult to remove even when the sugars are of a high degree of purity.

There is no doubt whatever of the fact that the liquid absorbed by the plant rootlets carries mechanically in solution particles of humus to all parts of the plant.

It thus appears that humus has a more direct use as a plant food than has been supposed by those who adopted *in toto* the mineral theory of Liebig, and this is shown by its nitrogen content, as studied by Hilgard; by the action of humates in supporting plant life, as investigated by Snyder, and by the actual increase in the content of nitrogen in plants, grown upon peaty soils, noticed in our own experiments.

It has been generally supposed by agricultural investigators that the acidity of a soil injurious to crops is found only in peaty or marshy soils. This idea has been found to be incorrect by the investigations of Wheeler, which have shown that many of the soils of Rhode Island, not subjected to overflow nor in any sense marshy or peaty, are so acid as to prevent the proper growth of crops. These soils are not particularly deficient in plant food, but ordinary crops fail to flourish when planted therein. The simple application of lime, in sufficient quantities to correct the acidity of the soil, is enough to convert those almost barren fields into highly productive areas.

The difficulty of estimating properly the acidity of the soil has been the chief obstacle in the way of a more thorough investigation of this subject. The acid reaction of peaty soils, as well as all others, is due, as a rule, to the presence of free humic acid or of acid humates. The exhaustion of the soil in any way for the determination of the moisture in the filtrate obtained gives imperfect and unsatisfactory results. In the titration of the extracts obtained the processes which are used in the saturation may act upon the humus bodies, decomposing them and producing fresh portions of humic acid and thus increasing the apparent acidity. This goes on with especial vigor in the presence of free oxygen.

To avoid this difficulty, Tacke has devised a method of determining the acidity in an environment free of oxygen. The essential principle of the apparatus is in having a flask, from which the air can be removed by any convenient method, preferably by a stream of hydrogen, so arranged that when the oxygen is entirely eliminated precipitated carbonate of lime, suspended in water free of oxygen, can be introduced and brought in contact with the finely divided peat or soil. In this way the decomposition of the finely divided calcium carbonate can only be effected by the

free acid or acid humates already formed, and no humus in the absence of oxygen can be converted into an acid and thus increase the amount of carbon dioxid evolved. The quantity of carbon dioxid evolved is estimated by the usual methods and thus an exact measure of the total acidity is secured. (Chemiker-Zeitung, March, 1897, p. 174.)

The claim has been repeatedly made that soda can replace potash to a certain extent in plant growth. The physical and chemical similarity between these two substances is so great that it would not be surprising to find also a physiological resemblance. Wagner, in fact, claims to have demonstrated that a slightly less quantity of potash is needed for plant growth, provided abundant supplies of sodium are present. These deductions of Wagner, however, have not been confirmed by other experimenters. When good effects have followed the application of soda it has been demonstrated that it is due to other causes than the replacement of potash in plant tissues. Soda in certain circumstances may act happily on inert plant food in the soil and render it assimilable. In this respect it doubtless can assist greatly in plant growth. In respect of the mineral food of plants it may be said that it appears to be of two kinds: First, the minerals which are essential, such as phosphoric acid, potash, lime and magnesia. A certain quantity of these mineral substances seem to be necessary for the production of a given quantity of dry plant tissue. But plants have also a general appetite for mineral substances, eating freely in addition to the quantity necessary to their proper nutrition. The exact physiological function of this excess of mineral food cannot be determined, and it is probable that it is largely accidental. Nevertheless, recent investigations have shown that plants thrive best where mineral food, even when non-essential, is liberally supplied, and in these cases soda doubtless plays its part, together with other non-essential matter.

In the light of our present knowledge, however, it must be denied that soda can, in any essential way, replace potash in plant growth.

In a recent re-study of the proteids of the maize kernel, Osborne has brought practically to a close his interesting and valuable contributions to our knowledge of the proteid matters existing in many common cereals. In a sample of yellow maize meal he finds 3.15 per cent. of a proteid soluble in a 0.2 per cent. solution of potash. This proteid contains 15.82 per cent. of nitrogen. The quantity of zein is 5 per cent., containing 16.32 per cent. of nitrogen. These two proteids comprise almost the whole of the proteid matter in the maize. In addition to these, there are minute quantities of edestin containing 18.10 per cent. of nitrogen; a globulin, containing 15.25 per cent. of nitrogen, and a proteose, containing 17 per cent. of nitrogen. Maysin exists to the extent of one-quarter of one per cent. and contains 16.70 per cent. of nitrogen.

As a result of all the determinations, it appears that the mean percentage of nitrogen in the proteids of maize is 16.057.

The proper factor for the multiplication of proteid nitrogen to determine the total weight of proteids in maize is, therefore, 6.22. This is so near the common factor of 6.25 as to make practically little difference in the statement of results. The factors by which nitrogen should be multiplied in order to obtain the weights of proteids in common cereals are: for wheat, 5.70; rye, 5.62; maize, 6.22; oats, 6.06, and barley, 5.82. This revision of the factors for determining the total amount of proteid matter is not only important as regards this matter itself, but also affects the number for the determination of the carbohy-

drates, which is usually made by difference. Agricultural analysts hereafter should use the factors mentioned instead of the common factor 6.25, which has been so long employed.

The use of the basic bessemer process for the manufacture of steel from phosphoriferous pig iron has not yet been fully established in this country. The agricultural importance of this branch of manufacture is found in the production of basic phosphatic slags. In Europe this industry has grown to an enormous magnitude, and it is estimated that at the present time the rate of production in that country is a million and a-half tons of basic slag annually. All this material has found a ready market in the fertilizer trade, and the result has been a corresponding depression in the prices of superphosphates.

The methods of valuing the fertilizing properties of basic slag have lately been worked out very thoroughly in different localities in this and other countries. The difficulties attending the solution of the phosphoric acid in acid ammonium citrate are found chiefly in the varying quantities of uncombined lime which the slags contain. This subject was introduced at the last meeting of the Association of Official Agricultural Chemists, but the discussion was only of a formal nature, it having been relegated to the next meeting.

In addition to the chemical methods of analysis the separation of the slags into silts of different magnitudes will probably prove of use. This cannot be accomplished by subsidence in water, on account of the solvent action of the water on the quicklime present. The substitution of alcohol of appropriate strength, however, obviates this difficulty and renders the mechanical separation of the slags easy of accomplishment.

In this country basic slags have been manufactured only at Pottstown, Pa., and at Troy, N. Y. I visited a large factory at Troy last winter, which was then in full action, but I believe it has been shut down on account of the low price of steel billets. It is believed, however, that a vast quantity of phosphatic iron ores will soon be brought into the market in this country and that the by-product, basic slags, will find a ready agricultural use.

Experience has shown that these slags act happily on sandy soils, and, in fact, in most cases can replace the acid phosphates where phosphoric acid is indicated in the application of fertilizers. The association of agriculture and manufacture in this respect cannot fail to be of value, and it may soon be possible to offer to the farmer available phosphoric acid, in the form of basic slags, at a lower price than can be profitably asked for acid phosphates.

In terminating this brief review of recent progress in agricultural chemistry, I am as fully aware as any of you of the imperfect nature of the *résumé* which has been given. I was not asked, however, until a short time ago to prepare this paper, and have been compelled to gather the information by piecemeal and in the intervals of other pressing duties. I am certain that in my hurry I have omitted many points of progress made by our own investigators which ought to have been incorporated in the paper. I only hope that the one who is next called upon to present a *résumé* of this progress may be given a longer time in which to prepare for his duties.

H. W. Wiley.

Department of Agriculture,
Washington, D. C.

THE MONTREAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA.

I.

The Geological Society of America assembled in Montreal, December 28th, for its